

Species Diversity, 1996, 1, 55–70

Marine Tubificidae (Oligochaeta) from Hokkaido, Northern Japan, with Descriptions of Two New Species

Yoshikazu Takashima and Shunsuke F. Mawatari

*Division of Biological Sciences, Graduate School of Science,
Hokkaido University, Sapporo 060, Japan*

(Received: 1 February 1996/Accepted: 6 June 1996)

Eight species of marine Tubificidae, including two new species and four first records from Japan, are reported from Hokkaido. *Nootkadrilus crassisetosus* sp. n. is distinguished from *N. verutus* Baker, 1982 in having penial setae of equal length. *Limnodriloides ezoensis* sp. n. differs from *L. victoriensis* Brinkhurst and Baker, 1979 by having an oesophagus without diverticulae. Three species, *Rhizodrilus pacificus* (Brinkhurst and Baker, 1979), *Aktedrilus knoellneri* Erséus, 1987 and *Tubificoides pseudogaster* (Dahl, 1960), are redescribed.

Key Words: Oligochaeta, marine Tubificidae, northern Japan, taxonomy, biogeography.

Introduction

Aquatic oligochaetes were formerly considered a predominantly limnic group with a few marine representatives. It has become necessary to change this view, however, as over the last two decades marine surveys have revealed more marine oligochaetes. In the Tubificidae, for example, the current number of marine species is over 400 and exceeds that of freshwater species, though only 40 marine species were recorded twenty five years ago (cf. Brinkhurst and Jamieson 1971).

In the eastern part of Asia, about 60 species of marine tubificids have been reported. Erséus (1984, 1990a, 1992) intensively studied the fauna of Southern China. Erséus *et al.* (1990) described material from northern China. Finogenova (1982a, b, 1985) and Finogenova and Shurova (1980) studied the tubificids of the Far East. In Japan, the only truly marine species previously known are: *Rhizodrilus pacificus* (Brinkhurst and Baker, 1979) from Hokkaido, northern Japan (Baker and Brinkhurst 1981); *Tubificoides imajimai* Brinkhurst, 1985 from central Japan (Brinkhurst 1985); and *Tubificoides brevicoleus* Brinkhurst, 1983 also from Hokkaido (Ohtaka 1987). However, more than three species would be expected to occur along the Japanese coast. A taxonomic survey was therefore conducted of marine tubificids in Hokkaido, northern Japan. This paper deals with eight species belonging to five genera including two new species and four species collected for the first time from Japan.

Materials and Methods

Material was collected by the first author from various parts of Hokkaido (see

species descriptions for locality details). Most sample sediments were taken from intertidal coastal waters, except for some samples of *Limnodriloides ezoensis* sp. n. which were obtained from subtidal bottom sediments using Ekman-Birge or Smith-McIntyre grabs. Each sediment sample was washed with sea water in a plastic bucket, and animals were extracted by decanting the suspension through a plankton net with a pore size of 100 μ m. Tubificid worms were sorted and transferred to Mg-free artificial sea water to prevent crystallization of Mg-salt, and then anaesthetized by a small amount of ethanol at about 6°C. Anaesthetized worms were fixed in 70% ethanol, dehydrated through ethanol series, cleared in xylene, and mounted whole in Canada balsam. Some specimens were stained with borax-carmin and differentiated with acidic alcohol. One specimen of *Limnodriloides ezoensis* sp. n. was sectioned and stained by Hematoxylin and Eosin to verify the existence of the prostatic pad in the atrial ampulla.

Original material of *Aktedrilus knoellneri* was used to compare with the present material. Type specimens were borrowed from the U. S. National Museum of Natural History, Smithsonian Institution (USNM), and from the Canadian Museum of Nature (NMCA). Professor C. Erséus (Swedish Museum of Natural History) kindly lent other specimens from his collection.

Observations were made with Nomarskii differential interference contrast microscopy. Figures were drawn with the aid of a camera lucida. Type material of the new species are deposited in the Division of Biological Sciences, Graduate School of Science, Hokkaido University (ZIHU), Sapporo, Japan.

Abbreviations used in figures: apr, anterior prostate; at, atrium; at1, ental part of atrium; at2, ectal part of atrium; ed, ejaculatory duct; eg, epidermal gland; mb, male bursa; mp, male pore; oes, oesophagus; p, penis; pp, pseudopenis; ppa, penial papilla; ppr, posterior prostate; pr, prostate gland; prp, prostatic pad; ps, penial seta; psa, penial sac; sf, sperm funnel; psh, penis sheath; sg, spermathecal gland; sp, spermatheca; spa, spermathecal ampulla; spd, spermathecal duct; spp, spermathecal pore; sps, spermathecal seta; spv, spermathecal vestibule; sz, spermatzozeugmata; tr, transverse ridge; vd, vas deferens; vd1, ental part of vas deferens; vd2, ectal part of vas deferens

Family **Tubificidae** Lamarck

Subfamily **Rhyacodrilinae** Hrabě

Genus ***Rhizodrilus*** Smith

Rhizodrilus pacificus (Brinkhurst and Baker, 1979) (Fig. 1)

Monopylephorus pacificus Brinkhurst and Baker, 1979, pp. 1561-1562, fig. 10.

Rhizodrilus pacificus (Brinkhurst and Baker): Baker and Brinkhurst 1981, pp. 955-956, figs 11, 12; Finogenova 1982a, pp. 13-14.

Rhizodrilus pacificus kurilensis Finogenova, 1982a, pp. 14-16, figs 1B, 2.

Material examined. 3 whole-mounted specimens: Funahama, Otaru, Hokkaido,

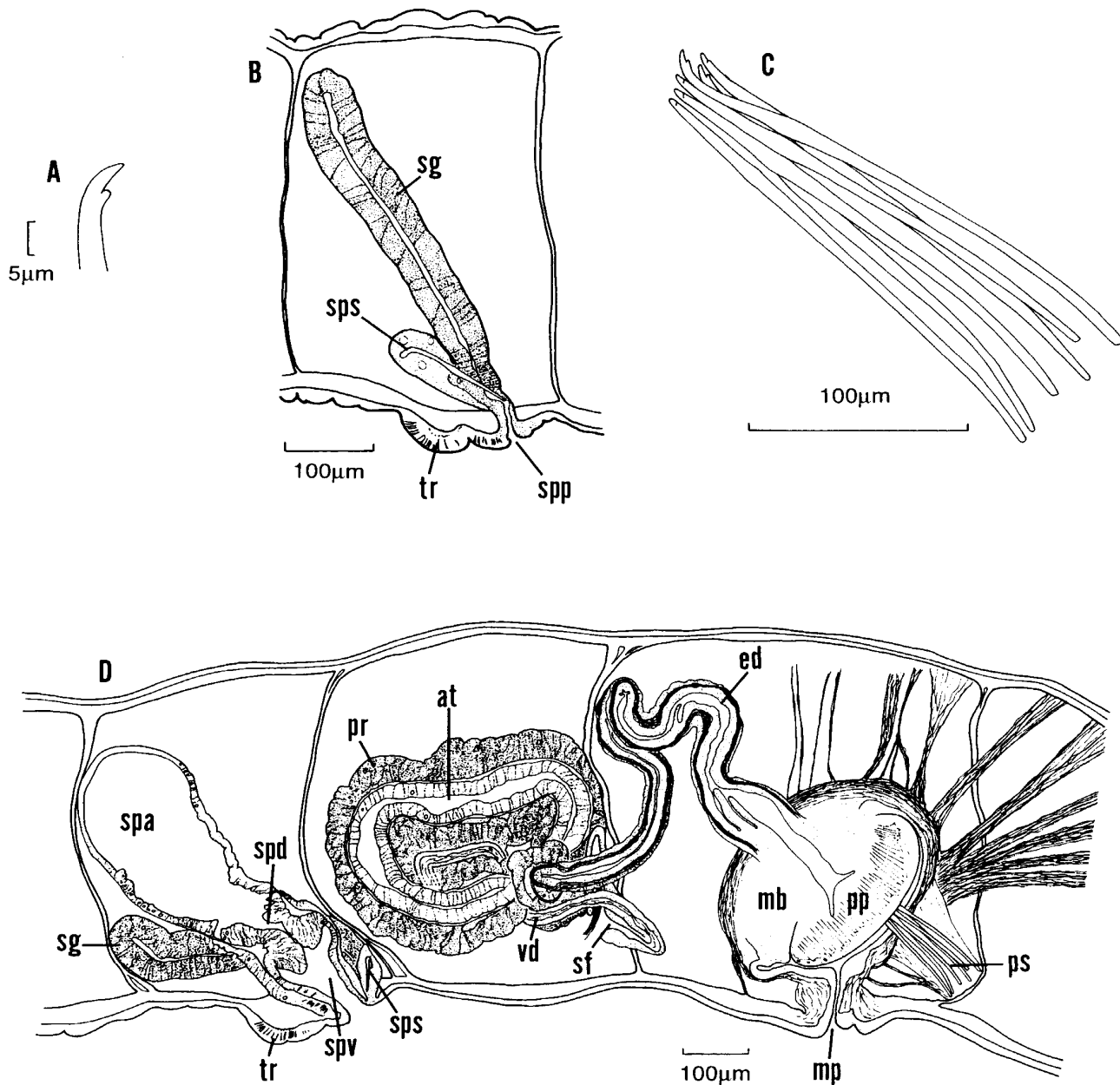


Fig. 1. *Rhizodrilus pacificus*. A, somatic seta; spermathecal seta and spermathecal gland in segment IX; C, penial setae; D, lateral view of spermatheca and male duct in segment IX-XI.

43° 04'N, 141° 03'E; intertidal, gravel (14 June 1992). 3 whole-mounted partly mature specimens: Oshoro Bay, Hokkaido, 43° 13'N, 140° 52'E; intertidal, gravel (13 March 1992).

Description of new material. Length 21.5-29.7mm; number of segments 71-114. Width 0.45-0.63mm at XI. Prostomium blunt conical to pointed, about as long as wide at base. Clitellum weakly developed, extending over 1/2 X-VII. Dorsal and ventral somatic setal bundles each consisting of 2-3 bifid setae in II-VIII, but (1)2(3) bifids thereafter; somatic setae (Fig. 1A) with upper tooth much longer and thicker than lower, 64-147 µm long, 3-6 µm wide at node. Ventral setae of IX modified as spermathecal setae (Figs 1B, D, sps), located immediately anterior or posterior to

spermathecal pores, 1-2 per bundle; spermathecal setae walking-stick shaped, single-pointed, 141-154 μm long, 6 μm wide at middle part, protruding from spermathecal pores. Ventral setae of XI modified as penial setae (Figs 1C, D, ps), protruding into male bursa from posterior, 6-7 per bundle; penial setae bifid, similar to somatic setae, 227-256 μm long, 6 μm wide. Male pore unpaired, mid-ventral, posteriorly in XI. Spermathecal pores paired, in line with ventral setae, in posterior-most part of IX. A ventral transverse ridge extends immediately anterior to spermathecal pores.

Pharyngeal glands present in IV-V. Oesophagus not modified. Coelomocytes spherical, numerous; diameter 16-22 μm .

Male genitalia (Fig. 1D), except for male bursa, paired. Sperm funnel asymmetrical. Vas deferens 570-830 μm long, 16-32 μm wide, turning in XI and extending into X to enter into atrium subapically. Atrium tubular with rounded ental end, winding, about 700-890 μm long, 45-64 μm wide; major part of atrium extending into X; atrium with non-ciliated thick inner epithelium and outer muscular lining 3-5 μm thick. Prostate glands surrounding all parts of atrium, communicating with inner epithelium of atrium at many points. Ejaculatory duct 620-1000 μm long, gradually widening ectally, with distinct outer muscular lining and folded inner epithelium. Ectal parts of ejaculatory ducts and invagination of body wall uniting and forming unpaired large male bursa (eversible pseudopenis?). Bursa 358-448 μm high, 256-288 μm wide, with conspicuously folded inner epithelium and distinct muscle layer. Retractor muscles linking bursa to dorsal side of the body wall.

Spermathecae (Fig. 1D) paired, in posterior part of IX, consisting of three parts: (1) ectal vestibules, formed by invagination of body wall, up to 1/4 of spermatheca; (2) indistinct ducts; and (3) thin-walled large ampullae. Spermathecal glands (Figs. 1B, D, sg) present in IX, 1 per spermatheca; this gland oblong to tubular, with narrow lumen, 480 μm long, 64-77 μm wide, associated with setal sac of spermathecal setae. Sperm in spermathecae absent in available specimens.

Remarks. *Rhizodrilus pacificus* was originally described from British Columbia, Canada by Brinkhurst and Baker (1979) as *Monopylephorus pacificus*. In the original description, they incorrectly noted the position of spermathecae as situated in X. Based on the Canadian and Japanese material, Baker and Brinkhurst (1981) later corrected this position as being in IX and transferred the species to *Rhizodrilus*. Finogenova (1982a) also redescribed the species based on Russian material and transferred it to *Rhizodrilus* unaware of Baker and Brinkhurst's work (1981). She established a subspecies *R. pacificus kurilensis* noting that the spermathecae and its pores were in IX in the Russian material. Her subspecies is virtually identical to the original, and therefore, *Rhizodrilus pacificus* should be treated as monotypic.

The present material is a second record of this species from Hokkaido, and conforms with the previous descriptions with the exception of one feature mentioned by Baker and Brinkhurst (1981). They noted that both the left and right spermathecal pores were connected, forming a transverse slit; the present material lacks such a slit. This difference may be due to difference in state of maturity (all the present specimens are precopulatory).

Although the spermathecal setae of this species are located on the body-axial side of the spermathecae, these setae were seen on either the anterior or posterior side of the spermathecae on preparations of whole-mounted worms. The spermathecal setae are probably pushed either side of the spermatheca when the worm is

compressed laterally between the glass slide and cover slip.

Distribution and habitat. Pacific coast of Canada; Far East Russia; and northern Japan. Intertidal.

Subfamily **Phallogrilinae** Brinkhurst

Genus **Akteredrilus** Knölner

Akteredrilus longitubularis Finogenova and Shurova, 1980

Akteredrilus longitubularis Finogenova and Shurova, 1980, pp. 65-69, figs 1-8.

Akteredrilus longitubularis Finogenova and Shurova: Erséus 1989, p. 17, figs 2q-r; 1990a, pp. 279-280, fig. 6; 1990b, pp. 264-265, fig. 16; 1993, p. 348.

Material examined. 1 whole-mounted specimen: Takashima, Otaru, Hokkaido, 43° 13'N, 141° 01'E; intertidal, gravel under decaying seaweed (5 September 1991). 4 whole-mounted specimens: Oshoro Bay, Hokkaido, 43° 13'N, 140° 52'E; intertidal, gravel (1991-1992).

Remarks. This is the first record of *Akteredrilus longitubularis* from Japan. *Akteredrilus longitubularis* is widely known from various parts of the Indo-west Pacific and the Caribbean (Finogenova and Shurova 1980; Erséus 1989, 1990a, b, 1993). Some specimens of this species were reported to lack a subdental ligament on the setae (Finogenova and Shurova 1980; Erséus 1989). The present material has this ligament, as do specimens from Hong Kong and Belize (Erséus 1990a, b). The present specimens are much longer (5.9-7.3 mm) than those previously reported from other localities: the shortest is 2.0mm from Russia and Southern China (Finogenova and Shurova 1980; Erséus 1990a), and the longest 3.9mm from Saudi Arabia (Erséus 1989). The number of segments in the Japanese material, however, is only slightly greater (36-44 segments) than previously recorded: a worm with the minimum number 25 segments was reported from Southern China by Erséus (1990a) and one with a maximum 39 segments from Russia by Finogenova and Shurova (1980). The difference in length may partly be attributable to anaesthetization of the present material before fixation.

Distribution and habitat. Far East Russia; Hong Kong; Saudi Arabia; Belize; Western Australia; and northern Japan (new record). Intertidal, sand or gravel.

Akteredrilus knoellneri Erséus, 1987

(Fig. 2)

Akteredrilus knoellneri Erséus, 1987a, pp. 114-116, fig. 4.

Material examined. NMCA-1986-0095, USNM 99983 (paratypes) and 5 other whole-mounted specimens (loaned by C. Erséus) from British Columbia (see Erséus 1987a). 35 whole-mounted specimens: mouth of the River Shizunai, Shizunai-cho, Hokkaido, 42° 20'N, 142° 22'E; intertidal, gravel (1992-1993).

Description of new material. Length 2.9-6.4 mm; number of segments about 27-40 (segmentation not clear at posterior end). Width 0.15-0.24mm at XI.

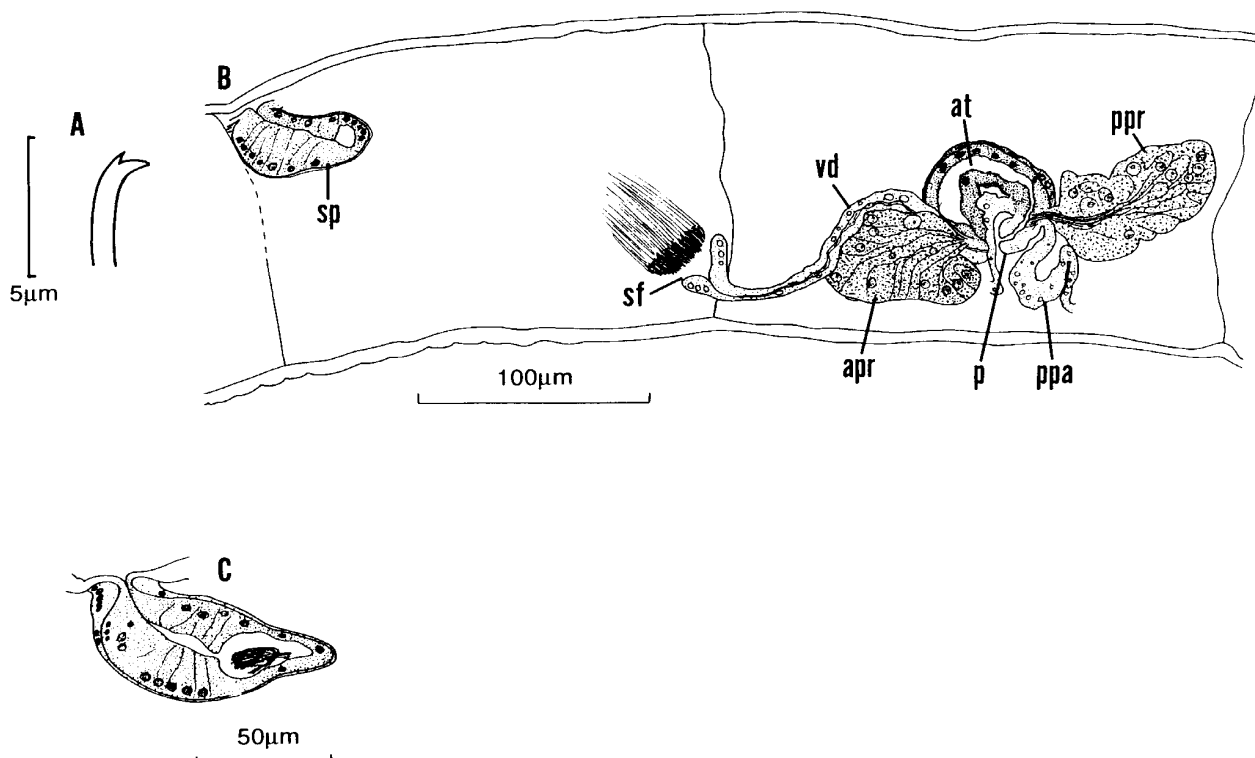


Fig. 2. *Aktedrilus knoellneri*. A, seta; B, lateral view of spermatheca and male duct in segment X-XI; C, spermatheca of another specimen.

Prostomium blunt conical, as long as wide at base. Clitellum extending over 1/2X-VII. Dorsal and ventral setal bundle consisting of 3-7 bifid setae in anterior segments, but (2)3-4(5) bifids thereafter; setae (Fig. 2A) with upper tooth shorter and thinner than lower, 30-37 μm long, about 1.5 μm wide at node. Ventral setae absent in XI. Male pores paired, in line with ventral setae, slightly posterior to middle of XI. Spermathecal pore unpaired, mid-dorsal, in anterior-most part of X.

Pharyngeal glands present in IV-VI. Oesophagus not modified. Coelomocytes absent.

Male genitalia (Fig. 2B) paired. Sperm funnel 19-27 μm wide, about as long as or slightly shorter than its width. Vas deferens 6-11 μm wide, slightly longer than atrium, entering atrium apically. Atrium cylindrical, somewhat coiled, about 80-100 μm long, 16-27 μm wide at middle part, with ciliated inner lumen and thin outer lining. Penis ectally widened, somewhat curved, 13-22 μm long, 14-18 μm wide ectally, without cuticular sheath. Copulatory sac enclosing penis and penial papilla; the latter formed by the fold of the sac, covering lateral and posterior sides of penis. Anterior prostate gland attached to the ental end of atrium. Posterior prostate entering into ectal part of atrium.

Spermatheca (Figs 2B, C) unpaired, 37-100 μm long, 20-49 μm wide, consisting of ectal thick-walled duct and ental thin-walled ampulla; the latter occupying about 1/3-1/2 of total length, narrower than duct. Sperm in spermathecal ampulla as loose bundle, not embedded in wall of ampulla.

Remarks. This is the first record of *Aktedrilus knoellneri* from Japan. The present

material conforms to the original description well, except in the following minor respects: (1) the penis is ectally widened in the Japanese material, but conical-to-thimble-shaped in the original material; (2) the spermatheca of the Japanese material is cylindrical to ectally tapered, gourd-shaped in the original specimens.

Distribution and habitat. Pacific coast of Canada and northern Japan (new record). Intertidal, marine or brackish-water, sand or gravel.

Genus *Nootkadrilus* Baker

Nootkadrilus crassisetosus sp. n.

(Fig. 3)

Material examined. *Holotype*. ZIHU 1022, whole-mounted specimen.

Type locality. The mouth of the River Shizunai, Shizunai-cho, Hokkaido, 42° 20'N, 142° 22'E; intertidal, gravel (19 March 1994).

Paratypes. ZIHU 1023-1026, 4 whole-mounted specimens from type locality (1992-1994).

Etymology. The epithet refers to the thick penial setae (*crassus*, Latin for thick).

Description. Length greater than 6.6 mm; number of segments more than 26 (complete specimens were not available). Width 0.29-0.40 mm at XI. Prostomium blunt conical, slightly shorter than its width at base. Clitellum extending over 1/2 X-VII. Dorsal and ventral somatic setal bundle consisting of (2)3(4) bifid setae; somatic setae (Fig. 3A) with upper tooth shorter and thinner than lower, 32-66 μm long, about 1.5-3 μm wide at node. Ventral setae of XI modified into penial setae, 4 per bundle; penial setae (Fig. 3B) single-pointed, flattened throughout their whole length and ectally hooked, 121-150 μm long, 11-13 μm thick at middle part. Male and spermathecal pores paired, in line with ventral somatic setae, posteriorly in XI and in anterior-most part of X, respectively.

Pharyngeal glands present in IV-VI. Oesophagus in IX not modified but thickened in one specimen. Coelomocytes absent.

Male genitalia (Fig. 3C) paired. Sperm funnel flattened, 43-48 μm wide. Vas deferens bipartite, consisting of two histologically different parts: (1) ental part thick with granulated inner epithelium composed of columnar cells, extending over X-XI, about 120-150 μm long, 40-56 μm wide; and (2) ectal part of vas deferens thin walled, not glandular, gradually tapering towards ectal end, about as long as ental part, 13-21 μm wide at middle portion and ectal end, entering atrium apically. Atrium bipartite; ental part fusiform, 96-104 μm long, 56-70 μm wide, with thick outer muscle layer (up to 22-35 μm thick) and narrow inner lumen; ectal part gradually widened ectally, slightly curved, covered with distinct muscle layer (3-8 μm thick), about 140-160 μm long, 40-64 μm wide at broadest part. Prostate gland situated posterior to ectal part of atrium, long and narrow, stalked, entering into ental portion of ectal part of atrium. Atrium terminating in rounded protrusible pseudopenis. Penial sac enclosing pseudopenis.

Spermathecae (Fig. 3C) paired, tubular, heavily muscular (outer muscle layer up to 8 μm thick), 180-290 μm long, 22-40 μm wide, divided into three parts: (1) vestibules with folded inner surface and bulbous ectal end, occupying ectal half of atrium; (2) ducts with lumen entally widened; and (3) ampullae with thin

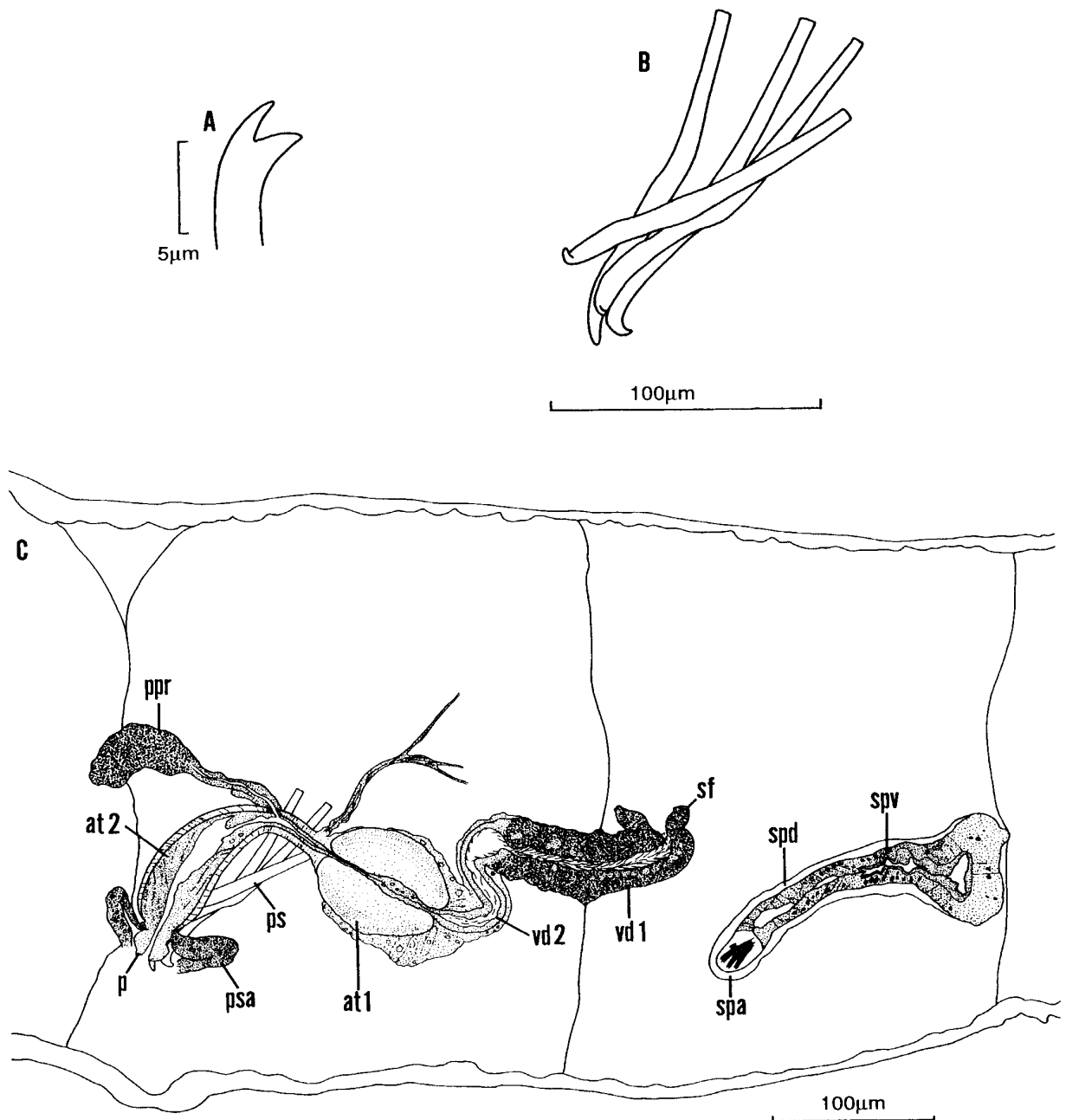


Fig. 3. *Nootkadrilus crassisetosus* sp. n. (holotype) A, somatic seta; B, penial setae; C, lateral view of spermatheca and male duct in segment X-XI.

epithelium, occupying ental $1/7$ - $1/8$ of atrium. Sperm in spermathecal ampulla forming loose, or sometimes rumpled bundles, partly embedded in wall of ampulla.

Remarks. *Nootkadrilus crassisetosus* sp. n. is closely related to *N. verutus* Baker, 1982, which also has heavily muscular atria and spermathecae. The new species, however, differs from *N. verutus* in the ental part of the atrium (termed "median ectal portion of atrium" by Baker 1982): the former species has a lumen running through the center of the atrial muscle layer, whereas the latter has a lumen running off the

center of the muscle layer (Baker 1982 referred to the muscle layer of *N. verutus* as "asymmetrical muscle layer about the lumen"). *Nootkadrilus crassisetosus* sp. n. is also distinguished from *N. verutus* by its penial bundles consisting of 4 setae all equally long (bundles with 4-6 long and 6-7 short penial setae in *N. verutus*).

Distribution and habitat. Known only from type locality (northern Japan). Intertidal, brackish-water, gravel.

Subfamily *Limnodriloidinae* Erséus

Genus *Limnodriloides* Pierantoni

Limnodriloides agnes Hrabě, 1967

Limnodriloides agnes Hrabě, 1967, pp. 339-344, figs 13-24.

Limnodriloides agnes Hrabě: Hrabě 1971a, p. 32; 1971b, p. 216; 1975, p. 114, figs 4-5; Cook 1969, pp. 23-24; Erséus 1984, pp. 168-169, figs 22; 1987b, pp. 76-77; 1990a, pp. 298-299; 1990c, p. 76; 1992b, p. 67; 1993, p. 378; Erséus *et al.* 1990, pp. 115-116, fig. 4.

Limnodriloides agnes agnes Erséus 1982, pp. 243-245, Figs 22-23.

Limnodriloides appendiculatus Pierantoni (*partim*): Boldt 1928, pp. 149-151, figs 2-3.

Material examined. 1 whole-mounted incomplete specimen lacking posterior segments from XXII: Denshin-hama, Muroran, Hokkaido, 42° 19'N, 141° 57'E; intertidal, gravel (20 July 1993).

Remarks. This is the first record of *Limnodriloides agnes* from Japan. Although this single specimen is incomplete, it conforms well with previous descriptions of the species. The present specimen lacks setae in both X and XI as observed in the individuals from northern China (Erséus *et al.* 1990).

Distribution and habitat. Black Sea; Mediterranean Sea; northern and southern China; Canary Islands; Western Australia; and northern Japan (new record). Intertidal and subtidal sands or gravel.

Limnodriloides ezoensis sp. n.

(Fig. 4)

Material examined. *Holotype*. ZIHU 1027, a whole-mounted specimen.

Type locality. Otaru port, Hokkaido, Japan, 43° 11'N, 141° 01'E; subtidal, anoxic mud (2 October 1991).

Paratypes. ZIHU 1028-1030, 3 whole-mounted specimens: Kamekawa, Kikonai-cho, Hokkaido, 41° 42'N, 140° 35'E; intertidal, gravel with smell of H₂S, under decaying seaweed (3 July 1992).

Other material. 23 whole-mounted and 1 sectioned specimens: data as for paratypes.

Etymology. The epithet derived from "Ezo", the old Japanese name for Hokkaido.

Description. Length 16.7-22.5 mm; number of segments about 47-69 (segmentation not clear in posterior end). Width 0.24-0.39mm at XI. Prostomium blunt conical, as long as wide at base. Clitellum extending over XI-1/2 or 2/3 VII; conspicuous epidermal glands observed on clitellum in borax carmine stained specimens (see Fig.

4B). Dorsal and ventral setal bundle consisting of (1)2-3(4) bifid setae in anterior segments, but only 1(2) bifids posteriorly; setae (Fig. 4A) with upper tooth thinner and slightly shorter than lower, $22-83\ \mu\text{m}$ long, $3.2-5.6\ \mu\text{m}$ wide at node. Ventral setae absent in X and XI. Male pores (Figs 4C, D, mp) paired, opening on both lateral sides of unpaired protrusible pseudopenis situated in mid-ventral, middle of XI. Spermathecal pore unpaired, mid-ventral, middle of X.

Pharyngeal glands present in IV-V. Oesophagus (Fig. 4B, oes) in IX widened and thick-walled; diverticulae absent. Coelomocyte absent.

Male genitalia (Figs 4C-E), except for median pseudopenis, paired. Sperm funnel entally everted, $43-73\ \mu\text{m}$ long, $54-73\ \mu\text{m}$ wide. Vas deferens $11-16\ \mu\text{m}$ wide, about as long as atrium, entering atrium apically. Atrium club-shaped, consisting of an ental ampulla and ectal duct, but the difference between them not distinct. Atrial ampulla oblong, $90-200\ \mu\text{m}$ long, $25-54\ \mu\text{m}$ wide, with thin outer lining and granulated, non-ciliated inner epithelium; prostatic pad (Figs 4C, E, prp) inconspicuous, located in ventral, ectal part of atrial ampulla. Prostate gland large, covering atrial ampulla except for the part that face to the lateral sides of body, communicating with prostatic pad. Atrial duct not granulated, with thin outer lining ($16-32\ \mu\text{m}$ wide); ectal parts of duct located very closely to each other, but opening separately and subapically on lateral sides of single protrusible pseudopenis.

Spermathecae (Figs 4C, D, sp) paired, consisting of: (1) thick-walled ectal ducts, $48-73\ \mu\text{m}$ long, $35-48\ \mu\text{m}$ wide; ental-most part of duct histologically different from other parts; and (2) large, thin-walled ampullae of varying shape, about $130-260\ \mu\text{m}$ long, $38-95\ \mu\text{m}$ wide. Sperm in spermathecal ampullae as slender, torch-shaped spermatozeugmata in post-copulatory specimens.

Remarks. *Limnodriloides ezoensis* sp. n. resembles *L. victoriensis*, known from Pacific coast of Canada (Brinkhurst and Baker 1979, Erséus 1982) and northern China (Erséus *et al.* 1990), with regard to features of the male genitalia and spermathecae. The new species, however, is distinguished from *L. victoriensis* by the following two characters (corresponding conditions in *L. victoriensis* in parentheses): (1) oesophagus lacking diverticulae in IX (possessing a pair of diverticula in this segment); (2) atrial duct not granulated (granulated); and (3) ventral setae of IX invariably not modified into spermathecal setae (may be modified into spermathecal setae).

Distribution and habitat. Northern Japan. Intertidal and subtidal, mud and gravel.

Subfamily **Tubificinae** Eisen

Genus **Tubificoides** Lastockin

Tubificoides pseudogaster (Dahl, 1960)

(Fig. 5)

Limnodrilus pseudogaster Dahl, 1960, pp. 13-17, figs 3-4, pl. 1.

Tubifex pseudogaster (Dahl): Brinkhurst 1962a, p. 328, figs 1k, m; 1962b, p. 307; 1963a, p. 25, figs 2, 9a-c; 1963b, p. 712; 1963c, p. 43, fig. 12f; 1965, p. 124, figs 2h-i; Brinkhurst and Kennedy 1962, p. 375; Brinkhurst and Jamieson 1971, p. 460; Pickavance and Cook 1971, p. 252.

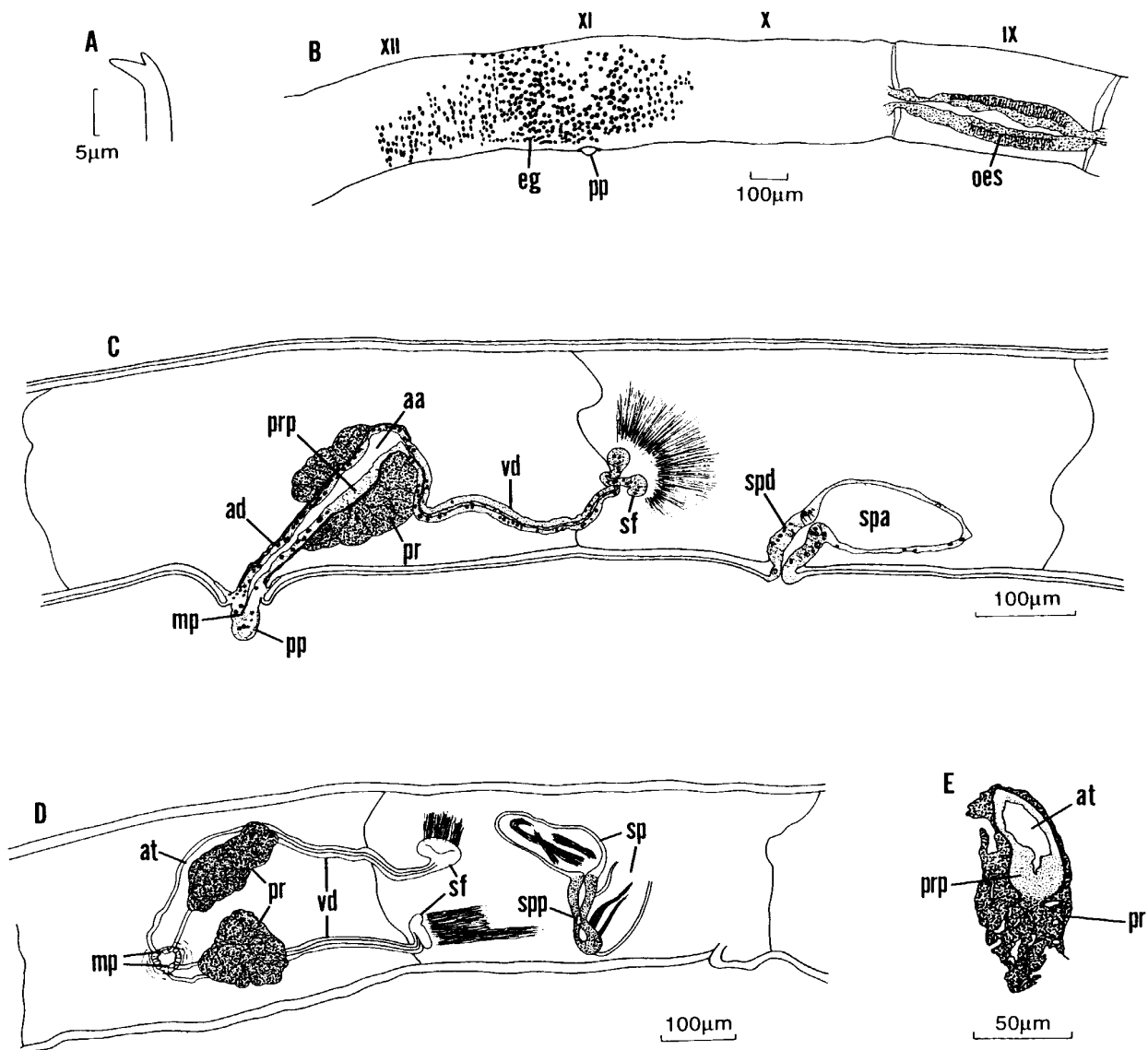


Fig. 4. *Limnodriloides ezoensis* sp.n. A, seta; B, oesophagus and spidermal glangs; C, lateral view of spermathecae and male duct in segment X-XI (holotype); D, ventral view of spermathecae and male ducts in segment X-XI (paratype); E, cross section through atril ampulla.

Isochaetides pseudogaster (Dahl): Hrabě 1966, p. 75.

Tubificoides pseudogaster (Dahl): Brinkhurst and Baker 1979, p. 1558, fig. 5, table 1; Baker 1980, pp. 337-342, figs 1-2; Finogenova 1985, pp. 80-83, fig. 5.

Material examined. 2 whole-mounted specimens: Aininkappu, Akkeshi-cho, Hokkaido, 43°01'N, 144°50'E; intertidal, gravel under stones (1 July 1992).

Description of new material. Length 13.3-15.7mm; number of segments 46-84. Width 0.83-0.86mm at XI. Prostomium convex, shorter than wide at base. Body wall

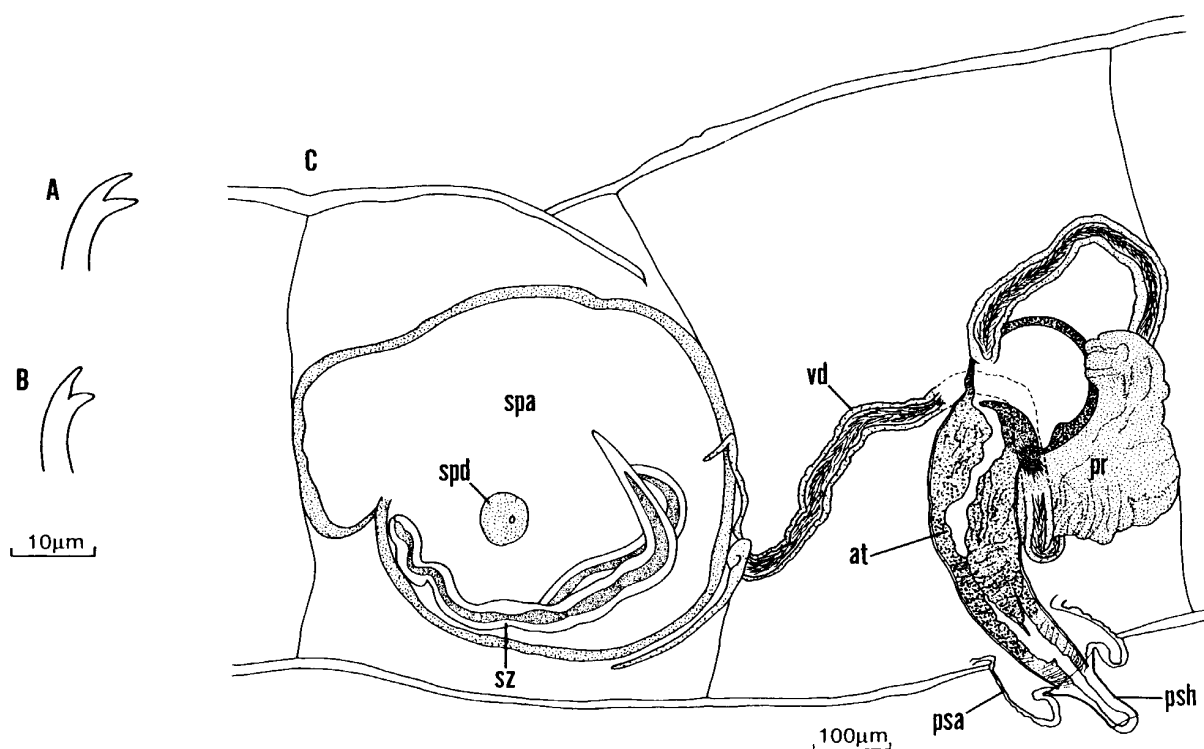


Fig. 5. *Tubificoides pseudogaster*. A, anterior seta; B, posterior seta; C, spermatheca and male duct in segment X-XI.

naked. Clitellum extending over XI-VII. Elongate posterior segments and epidermal glandular ring not observed. Dorsal and ventral setal bundles consisting of (1) 2-6 bifid setae in II-X, but (1) 2-3(4) bifids thereafter; setae (Figs 5A, B) with upper tooth slightly longer and thinner than lower, 64-96 μm long, 3-4 μm at node. Ventral setae absent in XI. Male pores paired, in line with ventral setae, posteriorly in XI. Spermathecal pores paired, laterally and anteriorly in X.

Pharyngeal glands present in IV-V. Oesophagus in IX thickened, but not conspicuous. Coelomocyte absent.

Male genitalia (Fig. 5C) paired. Sperm funnel broad. Vas deferens 2.6-2.7 times as long as atrium, 22-42 μm wide, entering atrium subapically. Atrium cylindrical, about 480-580 μm long, consisting of three histologically different parts: (1) rounded apical "head", occupying ental 1/3 of atrium, heavily granulated, 140-200 μm wide at broadest part; (2) middle part, tapering ectally, 100-115 μm wide at junction with apical head, with granulated inner epithelium and thin, finely annulated muscular lining; and (3) ectal part consisting of narrow, non-granulated cells. Prostate gland about as large as atrium, short-stalked, entering atrium opposite to entrance of vas deferens at base of apical head. Penis cylindrical, covered with cuticular sheath; sheath with or without ental flange, slightly tapering ectally, 64-80 μm long, 48-83 μm wide at ental end, 26-42 μm wide at ental tip.

Spermathecae (Fig. 5C) paired, consisting of two parts: (1) ectal narrow ducts, 130-140 μm long, 48-64 μm wide and; (2) ental thin-walled, large ampullae varying

in shape. Sperm in spermathecal ampulla as slender spermathegmata.

Remarks. *Tubificoides pseudogaster* is a widely distributed species, known from the NE Pacific and the NE and NW Atlantic. This is the first record of this species from Japan.

Baker (1980, 1984) noted that this species has a relatively simple genital system that varies in detail in material from different areas, i.e. in setal shape and number, form and length of penis sheath, and relative lengths of vas deferens to atrium. He (1984) pointed out the possibility that these "minor" differences are specific characters rather than the intraspecific variation. At present, however, it is impossible to determine whether or not *Tubificoides pseudogaster* sensu lato includes more than one taxon, as much of the previous material was incompletely described in not referring to any of the "minor" characters. Therefore, we have described the present material in detail, with a view towards a future solution to this problem.

Distribution and habitat. Baltic Sea; North Sea; Pacific and Atlantic coasts of Canada; Atlantic coast of United States; Far East Russia; and northern Japan (new record). Brackish-water and marine.

Tubificoides brevicoleus Baker, 1983

Tubificoides brevicoleus Baker, 1983, pp. 1242-1274, figs 1C-E, 3D, 4.

Tubificoides brevicoleus Baker: Ohtaka 1987, pp. 1-89, figs 1-5.

Material examined. 2 whole-mounted specimens: Aininkappu, Akkeshi-cho, Hokkaido, 43°01'N, 144°50'E; intertidal, gravel (1 July 1992).

Remarks. *Tubificoides brevicoleus* was originally described from British Columbia by Baker (1983). Subsequently, Ohtaka (1987) redescribed this species on the basis of material collected from Hokkaido. Additional specimens collected by the author conform to Ohtaka's description.

Distribution and habitat. Pacific coast of Canada and Northern Japan. Intertidal sands with or without shell debris.

Discussion

The present study has increased the number of described species of marine Tubificidae in Hokkaido from two to eight. Three of these eight species (*Akteredilus longitubularis*, *Limnodriloides agnes*, and *Tubificoides pseudogaster*) are nearly cosmopolitan, known from both Pacific and Atlantic Oceans. Two of the remaining five (*A. knoellneri* and *T. brevicoleus*) were previously known from NE Pacific, i. e. British Columbia, Canada (Erséus 1987a; Baker 1983). The sixth species from Hokkaido (*Rhizodrilus pacificus*) has been reported from the Kurile Islands, adjacent to Hokkaido (Finogenova 1982) and also from British Columbia (Brinkhurst and Baker 1979; Baker and Brinkhurst 1981). *Limnodriloides ezoensis* sp. n. is closely related to *L. victoriensis* from British Columbia and northern China. Another new species, *Nootkadrilus crassisetosus* sp. n., belongs to a genus previously only known from NE Pacific. Thus, the marine tubificid fauna of Hokkaido is similar to that of British Columbia. In more general terms, the marine tubificid fauna of NW Pacific has

an affinity with that of NE Pacific.

In contrast to this, there are few similarities between marine tubificids faunas of northern China and Hokkaido, although the two regions face each other across the Sea of Japan. Among the eight tubificids from the Yellow Sea, reported by Erséus *et al.* (1990), only one species, *Limnodriloides agnes*, was found in the present study, and the remaining seven are regarded as subtropical forms. In Far East Russia, eleven tubificid species have been reported (Finogenova 1982a, b, 1985; Finogenova and Shurova 1980). Most of them are endemic or widely distributed species. Among the three tubificids (*R. pacificus*, *A. longitubularis*, and *T. pseudogaster*) collected from both Hokkaido and Far East Russia, the latter two species are cosmopolitan. The tubificid fauna of Far East Russia is therefore, perhaps not very similar to that of Hokkaido. The present survey is largely based on intertidal samples. However, as more than two thirds of the world's marine Tubificidae are known from the subtidal zone, there are probably many more species still to be found from the subtidal zone of Hokkaido. Future surveys of subtidal tubificids of Hokkaido may clarify the relationships between the fauna of Hokkaido and those of other regions.

Acknowledgments

We are grateful to R. M. Woolacott and M. J. Weedon for their critical reading of the manuscript and for their efforts to correct our inappropriate use of English; to A. Ohtaka for his expert guidance in tubificid taxonomy; to C. Erséus for the loan of material, for his helpful taxonomic advice, and for encouragement and moral support; to C. Bright and J. A. Fournier for the loan of museum specimens; to K. Shinta, T. Sato, M. Moroi, H. Yoshioka and A. Hase for their kind support in collecting specimens.

References

- Baker, H. R. 1980. A redescription of *Tubificoides pseudogaster* (Dahl) (Oligochaeta: Tubificidae). Transactions of the American Microscopical Society 99: 337-342.
- Baker, H. R. 1982. Two new phallodriline genera of marine Oligochaeta (Annelida: Tubificidae) from the Pacific Northeast. Canadian Journal of Zoology 60: 2487-2500.
- Baker, H. R. 1983. New species of *Tubificoides* Lastockin (Oligochaeta; Tubificidae) from the Pacific Northeast and the Arctic. Canadian Journal of Zoology 61: 1270-1283.
- Baker, H. R. 1984. Diversity and zoogeography of marine Tubificidae (Annelida, Oligochaeta) with notes on variation in widespread species. Hydrobiologia 115: 191-196.
- Baker, H. R. and Brinkhurst, R. O. 1981. A revision of the genus *Monopylephorus* and redefinition of the subfamilies Rhyacodrilinae and Branchiurinae (Tubificidae: Oligochaeta). Canadian Journal of Zoology 59: 939-965.
- Boldt, W. 1928. Mitteilung über Oligochaeten der Familie Tubificidae. Zoologischer Anzeiger 75: 145-151.
- Brinkhurst, R. O. 1962a. A check-list of British Oligochaeta. Proceedings of the Zoological Society of London 138: 317-330.
- Brinkhurst, R. O. 1962b. A re-description of *Tubifex newaensis* (Michaelsen), (Oligochaeta, Tubificidae) with a consideration of its taxonomic position in the genus. Internationale

- Revue der gesamten Hydrobiologie 47: 307-312.
- Brinkhurst, R. O. 1963a. Taxonomical studies on the Tubificidae (Annelida, Oligochaeta). Internationale Revue der gesamten Hydrobiologie. Systematische Beihefte 48: 7-89.
- Brinkhurst, R. O. 1963b. Notes on the brackish-water and marine species of Tubificidae (Annelida, Oligochaeta). Journal of the Marine Biological Association of the United Kingdom 43: 709-715.
- Brinkhurst, R. O. 1963c. A guide for the identification of British aquatic Oligochaeta. Scientific publication. Freshwater Biological Association 22: 1-55.
- Brinkhurst, R. O. 1965. Studies on the North American aquatic Oligochaeta. II. Tubificidae. Proceedings of the Academy of Natural Sciences of Philadelphia 117: 117-172.
- Brinkhurst, R. O. 1985. A further contribution to the taxonomy of the genus *Tubificoides* Lastockin (Oligochaeta: Tubificidae). Canadian Journal of Zoology 63: 400-410.
- Brinkhurst, R. O. and Baker, H. R. 1979. A review of the marine Tubificidae (Oligochaeta) of North America. Canadian Journal of Zoology 57: 1553-1569.
- Brinkhurst, R. O. and Jamieson, B. G. M. 1971. Aquatic Oligochaeta of the World. Oliver and Boyd, Edinburgh. 860 pp.
- Brinkhurst, R. O. and Kennedy, C. R. 1962. Some aquatic Oligochaeta from the Isle of Man with special reference to the Silver Burn Estuary. Archiv für Hydrobiologie 58: 367-376.
- Cook, D. G. 1969. The Tubificidae (Annelida, Oligochaeta) of Cape Cod Bay with a taxonomic revision of the genera *Phallodrilus* Pierantoni, 1902, *Limnodriloides* Pierantoni, 1903 and *Spiridion* Knollner, 1935. Biological Bulletin 136: 9-27.
- Dahl, I. O. 1960. The oligochaete fauna of 3 Danish brackish water areas. Meddelelser fra Danmarks Fiskeri- og Havundersøgelser 2: 1-20.
- Erséus, C. 1982. Taxonomic revision of the marine genus *Limnodriloides* (Oligochaeta: Tubificidae). Verhandlungen des Naturwissenschaftlichen Vereins in Hamburg (N. F.) 25: 207-277.
- Erséus, C. 1984. The marine Tubificidae (Oligochaeta) of Hong Kong and Southern China. Asian Marine Biology 1: 135-175.
- Erséus, C. 1987a. Taxonomic revision of the marine interstitial genus *Akteredrilus* (Oligochaeta, Tubificidae), with descriptions of three new species. Stygologia 3: 107-124.
- Erséus, C. 1987b. A new species of *Phallodrilus* and records of two other marine Tubificidae (Oligochaeta) from the Mediterranean coast of Israel. Israel Journal of Zoology 33 (1984/85): 73-78.
- Erséus, C. 1989. Marine Tubificidae (Oligochaeta) of the Arabian Gulf coast of Saudi Arabia (Part 5). Fauna of Saudi Arabia 10: 11-19.
- Erséus, C. 1990a. Marine Oligochaeta of Hong Kong. Pp. 259-335. In: Morton, B. (Ed.) *Proceedings of the Second International Marine Biological Workshop: The Marine Flora and Fauna of Hong Kong and Southern China, Hong Kong, 1986*. Vol. 1. Hong Kong University Press, Hong Kong.
- Erséus, C. 1990b. The marine Tubificidae (Oligochaeta) of the barrier reef ecosystems at Carrie Bow Cay, Belize, and other parts of the Caribbean Sea, with descriptions of twenty-seven new species and revision of *Heterodrilus*, *Thalassodriloides* and *Smithsonidrilus*. Zoologica Scripta 19: 243-303.
- Erséus, C. 1990c. The marine Tubificidae and Naididae (Oligochaeta) of South-Western Australia. Pp. 43-88. In: Wells, F. E., Walker, D. I., Kirkman, H. and Lethbridge, R. (Eds) *Proceedings of the Third International Marine Biological Workshop: The Marine Flora and Fauna of Albany, Western Australia*. Vol. 1. Western Australian Museum, Perth.
- Erséus, C. 1992a. Hong Kong's marine Oligochaeta: a supplement. Pp. 157-180. In: Morton, B.

- (Ed.) *The Marine Flora and Fauna of Hong Kong and Southern China* III. *Proceedings of the Fourth International marine biological Workshop: The Marine Flora and Fauna of Hong Kong and Southern China, Hong Kong, 1989*. Hong Kong University Press, Hong Kong.
- Erséus, C. 1992b. Groundwater and marine intertidal Tubificidae (Oligochaeta) from the Canary and Cabo Verde Islands, with descriptions of two new species. *Bijdragen tot de Dierkunde* 62: 63-70.
- Erséus, C. 1993. The marine Tubificidae (Oligochaeta) of Rottnest Island, Western Australia. Pp. 331-390. *In*: Wells, F. E., Walker, D. I., Kirkman, H. and Lethbridge, R. (Eds) *Proceedings of the Fifth International Marine Biological Workshop: The Marine Flora and Fauna of Rottnest Island, Western Australia*. Western Australian Museum, Perth.
- Erséus, C., Sun Daoyuan, Liang Yanling and Sun Bin. 1990. Marine Oligochaeta of Jiaozhou Bay, Yellow Sea coast of China. *Hydrobiologia* 202: 107-124.
- Finogenova, N. P. 1982a. Revision of the genus *Monopylephorus* Levinsen, 1883 (Oligochaeta, Tubificidae). *Zoologicheskii Zhurnal* 61: 5-17. [In Russian]
- Finogenova, N. P. 1982b. *Ainudrilus oceanicus* a new genus and species of the family Tubificidae (Oligochaeta). *Zoologicheskii Zhurnal* 61: 1255-1258. [In Russian]
- Finogenova, N. P. 1985. The tubificid fauna (Oligochaeta) of the Far Eastern Seas of the U.S.S.R. Pp. 72-85. *In*: Kafanov, A. J. (Ed.) *Benthos and its environment in the shelf zones of Sakhalin*. Far Eastern Science Center of the U.S.S.R. Academy of Sciences, Vladivostok. 120 pp. [In Russian]
- Finogenova, N. P. and Shurova, N. M. 1980. A new species of the genus *Aktedrilus* (Oligochaeta, Tubificidae) of the littoral zone of the Sea of Japan. Pp. 65-69. *In*: Kusakin, O. G. (Ed.) *Coastal plankton and benthos in the northern parts of the Sea of Japan*. Academy of Sciences, Vladivostok, 116pp. [In Russian]
- Hrabě, S. 1966. New or insufficiently known species of the family Tubificidae. *Spisy Přírodovědecké Fakulty, Universita v Brně* 470: 57-76.
- Hrabě, S. 1967. Two new species of the family Tubificidae from the Black Sea, with remarks about various species of the subfamily Tubificinae. *Spisy Přírodovědecké Fakulty, Universita v Brně* 485: 331-356.
- Hrabě, S. 1971a. A note on the Oligochaeta of the Black Sea. *Věstník Československé Společnosti Zoologické* 35: 32-34.
- Hrabě, S. 1971b. On new marine Tubificidae of the Adriatic Sea. *Scripta Facultatum Scientiarum naturalis Ujep Brunensis, Biologia* 3 1: 215-226.
- Hrabě, S. 1975. Second contribution to the knowledge of marine Tubificidae (Oligochaeta) from the Adriatic Sea. *Věstník Československé Společnosti Zoologické* 39: 111-119.
- Ohtaka, A. 1987. New record of *Tubificoides brevicoleus* Baker (Oligochaeta, Tubificidae) from the Pacific coasts of Hokkaido, Northern Japan. *Journal of the Faculty of Science, Hokkaido University. Series 6, Zoology* 25: 1-8.
- Pickavance, J. R. and Cook, D. G. 1971. *Tubifex newfei* n. sp. (Oligochaeta, Tubificidae) with a preliminary reappraisal of the genus. *Canadian Journal of Zoology* 49: 249-254.